

What is claimed is:

1. A method for forming a metallic overlay comprising:

supplying a metal substrate with a thermal expansion coefficient “X”;

supplying a metal alloy which has a thermal expansion coefficient “Y”, wherein $Y > X$;

5 melting said metal alloy and applying said metallic alloy to said metal substrate to form an alloy/substrate interface;

forming metallurgical bonds between said metallic alloy and said substrate at said alloy/substrate interface; and

causing said alloy to shrink while said alloy is constrained at said alloy/substrate interface
10 thereby developing a residual compressive stress in said metallic alloy.

2. The method of claim 1 wherein said alloy is comprised of a mixture of Fe, Cr, Mo, W, B, C, Si and Mn.

3. The method of claim 2, wherein Fe is present at levels above 50.0 wt %.

4. The method of claim 2, wherein Fe, Cr, Mo, and W comprise at least 90 wt % of
15 said mixture.

5. The method of claim 1 wherein Fe and Cr comprise at least 90 wt % of said mixture, and Cr is present at levels of about 1.0 wt. %, and Mo is present at levels of about 1.0 – 2.0 wt %.

6. The method of claim 1 wherein Fe and Cr comprise at least 90 wt. % of said
20 mixture, and Cr is present at levels of about 1.0 wt. %, and Mo is present at levels of about 1.0 – 2.0 wt. %, and W is present at levels of about 3.0 – 4.0 wt %, B is present at levels of about 1.0 – 2.0 wt %, C is present at levels of about 0.1 – 1.0 wt %, Si is present at levels of 0.1 – 1.0 wt % and Mn is present at levels of 0.1 – 1.0 wt %.

7. The method according to claim 2 wherein said metallic alloy has a composition of about 65.9 wt % Fe, 25.3 wt % Cr, 1.0 wt % Mo, 1.8 wt % W, 3.5 wt % B, 1.2 wt % C, 0.5 wt % Si, 0.8 wt % Mn.

8. The method according to claim 2 wherein said metallic alloy has a composition of 64.9 wt % Fe, 26.0 wt % Cr, 1.0 wt % Mo, 1.4 wt % W, 3.6 wt % B, 1.2 wt % C, 1.0 wt % Si, 0.8 wt % Mn.

9. The method according to claim 1 wherein said metallic alloy has a composition of 68.0 wt % Fe, 23.2 wt % Cr, 1.2 wt % Mo, 1.5 wt % W, 3.6 wt % B, 0.9 wt % C, 0.7 wt % Si, 0.8 wt % Mn.

10. The method according to claim 1 wherein applying said metallic alloy comprises welding.

11. The method according to claim 1 wherein applying said metallic alloy comprises thermal spray coating.

12. The method according to claim 1 wherein said metallic alloy has a coefficient of thermal expansion greater than 15% of that of the base substrate.

13. The method according to claim 1 wherein said iron based metallic alloy has a coefficient of thermal expansion in the range of 12 to 17 ppm/°C.

14. A method for forming a metallic overlay comprising:
supplying a metal substrate with a thermal expansion coefficient "X";
supplying a metal alloy which has a thermal expansion coefficient "Y", wherein $Y > X$ and wherein said metal alloy has a yield strength "Z";

melting said metal alloy and applying said metallic alloy to said metal substrate to form an alloy/substrate interface;

forming metallurgical bonds between said metallic alloy and said substrate at said alloy/substrate interface; and

causing said alloy to shrink while said alloy is constrained at said alloy/substrate interface thereby developing a residual compressive stress in said metallic alloy, wherein said compressive stress does not exceed the yield strength “Z”.

15. The method of claim 14 wherein said compressive yield strength is greater than about 1520 MPa at room temperature.

16. A method for forming a metallic overlay comprising:

supplying a metal substrate with a thermal expansion coefficient “X”;

supplying a metal alloy which has a thermal expansion coefficient “Y”, wherein $Y > X$ and wherein said metal alloy has a yield strength “Z”;

melting said metal alloy and applying said metallic alloy to said metal substrate to form an alloy/substrate interface;

forming metallurgical bonds between said metallic alloy and said substrate at said alloy/substrate interface; and

causing said alloy to shrink while said alloy is constrained at said alloy/substrate interface thereby developing a residual compressive stress in said metallic alloy, wherein said compressive stress does not exceed the yield strength “Z” and wherein said metal alloy has a hardness of greater than about 850 kg/mm².

17. A method for forming a metallic overlay comprising:

supplying a metal substrate;

supplying a metal alloy;

melting said metal alloy and applying said metallic alloy to said metal substrate to form an alloy/substrate interface;

forming metallurgical bonds between said metallic alloy and said substrate at said alloy/substrate interface; and

5 causing said alloy to cool to provide said alloy with a fracture toughness greater than 200 MPa m^{1/2} and a hardness greater than 5 GPa.